Accounting for Economic Growth in the Netherlands since 1913

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1. Introduction

The development of the Dutch economy during the twentieth century has been characterised by major changes in structure and substantial variations in growth rates. Some of these changes are similar to those in many other countries in Northwest Europe, such as the rapid increase in per capita income and productivity during the 1950s and 1960s. However, other aspects of Dutch economic growth during this century are less common, for example its relatively good performance during the years of World War I, the dismal performance during the 1930s, the relatively high level of labour productivity, the decline in the comparative level of per capita income compared to neighbouring countries during the 1980s and the recent acceleration in per capita income growth.

This paper applies a growth accounting approach to decompose the growth of real GDP between 1913 and 1994 into the contribution of labour, capital input and productivity growth. The growth accounting approach departs from the concept of a production function, in which the rise in real output is related to the growth in the number of persons employed, hours worked, the non-residental capital stock and the stock of human capital which originates from investments in education and research and development.

In an earlier paper we also included a growth accounting scheme for the Netherlands, but it only went back to 1950 and was of a cruder nature than what we provide here (van Ark, de Haan and de Jong, 1994). Maddison (1991) applied a growth accounting approach for six countries, including the Netherlands, which included a benchmark year estimate for 1913.[1]

In this paper we provide growth accounting estimates on an annual basis since 1913. We partly rely on existing estimates, such as those on population and GDP growth since 1921. In other cases we apply new estimates, for example for GDP from 1913 to 1921, and employment and the non-residential capital stock for the whole period.

We emphasise from the outset that our estimates are still of a tentative nature, but in our view these are the best which are available at present. The series which are required for a full scale growth accounting study still suffer from some important deficiencies. For example, until very recently there was hardly any quantitative information on the growth of the Dutch economy during the period 1913 to 1921 except a crude estimate of the growth of real national income from the Dutch Central Bureau of Statistics. We now make use of revised, but as yet unpublished, estimates on GDP which have been constructed in the framework of the project on the reconstruction of the historical national

accounts of the Netherlands. The new estimates on the capital stock from Groote, Albers and de Jong (1996) require further scrutiny, in particular on the assumptions on asset lives and retirement patterns of the stock. We also include in our estimates of intangible capital an estimate of the R&D stock, but only from 1950 onwards. Finally, the national accounts estimates on GDP and employment for the war-period (1940-1945) as well as the 1950s and 1960s require substantial revision.[2] We attach three appendices to this paper explaining our sources and procedures, and we invite other scholars to improve on these series where possible.

Section 2 presents key measures on growth and comparative levels of per capita income and labour productivity for the economy as a whole and major sectors, which are compared with the average for eleven Northwest European countries and with the United States.[3] Section 3 quantifies the growth of labour and capital input, the latter being divided up into an estimate of physical and human capital input. It then goes on to deal with the change in total factor productivity. Here we also consider to what extent recent insights from the "new growth" literature affect our view of the growth to the Dutch economy. Section 4 discusses some additional factors explaining the comparative performance of the Dutch economy, which include the productivity performance by sector of the economy, the labour market situation in the Netherlands, capital intensity and factors relating to human capital and research and development. Section 5 summarises some of the main points which in our view have determined the growth process.

2. Growth Performance in an International Perspective

Between 1913 and 1994 the Dutch economy experienced a somewhat faster growth of real GDP, but a somewhat slower growth in per capita income and labour productivity than on average in Northwest Europe. Table 1 shows that the annual compound growth rate of real GDP between 1913 and 1994 was 3.0 for the Netherlands compared to 2.8 per cent for Northwest Europe. In contrast GDP per capita in the Netherlands grew at 1.8 per cent on average compared to 2.0 per cent for Northwest Europe, and labour productivity grew at 2.6 per cent in the Netherlands versus 2.7 per cent in Northwest Europe. Table 2 shows that the Dutch advantage in the level of per capita income turned from a surplus of 10 percentage points over Northwest Europe in 1913 into a shortfall of 9 percentage points in 1987. The Dutch productivity advantage over Northwest Europe was 24 percentage points in 1913 but only 13 percentage

points in 1994. Compared to the United States, the Dutch economy showed only a slight improvement in terms of per capita income but a very large improvement in terms of labour productivity.

[tables 1 and 2 here]

The divergence between the comparative performance in terms of GDP and per capita income (and productivity) growth is due to one of the most constant factors of Dutch economic growth during the twentieth century, namely the rapid growth of the population. The annual compound growth rate of the population in the Netherlands for the period 1913 to 1994 as a whole was 1.1 per cent compared to 0.6 per cent for Northwest Europe. The Dutch population growth was therefore only marginally lower than the population growth in the United States.

Table 1 shows that the comparative performance of the Netherlands differs substantially over the subperiods. During the period 1913 to 1929 the Dutch economy fared substantially better than Northwest Europe. This can mainly be ascribed to the fact that the Netherlands stayed out of the First World War and actively benefitted from its neutrality. From 1913 to 1921 output rose at 2.6 per cent a year in the Netherlands whereas it declined at 0.4 per cent on average for Northwest Europe as a whole. By 1929 the Dutch economy had reached a per capita income level of 23 per cent above the Northwest European average, and a productivity level which was 47 per cent higher than in Northwest Europe.

Between 1929 and 1950 the Dutch advantage in per capita income and productivity over Northwest Europe virtually disappeared (see table 2). During the 1930s the economy was severely hit by the depression. The Netherlands stuck to the gold standard until 1936, which seriously affected competitiveness on the world market. Per capita income during these years declined in absolute terms and productivity growth was very slow. During the period 1940-1945 the Dutch economy was negatively affected by the war and the German occupation, which explain the further decline in per capita income of 0.4 per cent a year between 1938 and 1947.[4]

Between 1947 and 1973 the Dutch economy grew somewhat faster than in the other Northwest European countries, but because of the rapid rise in population and employment, per capita income and productivity did not accelerate more than the Northwest European growth rate. The period after 1973 showed a strong slowdown in growth, but in contrast to Northwest

Europe as a whole, the slowdown was particularly severe during the first half of the 1980s rather than during the 1970s. Since 1987 the Netherlands has shown a significant acceleration in real GDP and per capita income growth, but productivity growth has slowed down even further.[5]

3. Accounting for Output, Factor Inputs and Productivity

Real Output

Table 3 shows that the Netherlands has had two periods of rapid growth in real GDP since 1913. The first was the period from 1921 to 1929, and the second from 1947 to 1973. In contrast, real output growth was extraordinary slow during the period 1929 to 1938 and from 1979 to 1987.

[table 3 here]

The table also shows the corresponding estimates of GDP in current prices and the implicit deflator. On average, prices have risen at 4 per cent over the period as a whole. The period 1921-1938 has been a deflationary period. Prices rose relatively rapidly between 1913 and 1921 (9 per cent per year on average), between 1960 and 1973 (6.5 per cent) and between 1973 and 1979 (7.4 per cent). Price increases have been very moderate since 1979 and in particular since 1987.

Labour Input

Diagram 1 shows that the rapid growth of the population in the Netherlands was accompanied by a rapid increase in employment except between 1913 and 1929 and between 1979 and 1987. Especially during the second half of the 1930s and since the mid 1980s employment grew faster than the population. However, much of that acceleration in the growth of persons employed was no more than a catch-up process to account for the continuously rising share of the population of working age (between 20 and 64 years old) in particular since the mid 1960s.

[diagram 1 here]

The rise in total labour input, that is the total number of hours worked, was much slower than that of persons employed because of the continuous decline in the number of working hours per person throughout the century. Diagram 1 shows that the total number of hours worked in the Netherlands fell somewhat between 1913 and the mid 1920s, dropped rapidly during the mid 1930s and showed a continuously falling trend from the mid 1960s until the mid 1980s. Since 1987 the total number of hours has slightly increased.

The two factors associated with the trends in employment and working hours are the relatively late rise in the participation of women in the labour force, and the decline in the number of hours worked per person. In 1950 the average participation rate, defined as the share of the labour force in the total population aged from 15 to 64 years, was 76 per cent for the eleven northwest European countries; by 1994 it was 72.5 per cent.[6] Table 4 shows that the corresponding figures for the Netherlands were much lower. Labour force participation declined between 1913 and 1960, but increased between 1960 and 1994 primarily because of a rapid rise in the proportion of women in the labour force by 18 percentage points from 22.3 to 40.7 per cent. During the same period, the participation rate of men dropped due to the introduction of early retirement schemes and the rapid increase in the number of people who received disability benefits, in particular during the 1970s and 1980s.

[table 4 here]

Annual hours worked per person employed in the Netherlands fell dramatically between 1913 and 1921. The standard working week declined from about 60 hours in 1916 to 48 hours in 1920, and then remained fairly constant until 1960. From 1960 to 1975 a further decline from 48 to 40 hours per week occurred, explaining the decline by 300 hours per person per year over that period, which was not very different from that in other Northwest European countries. However, the 25 per cent fall in working hours per person in the Netherlands between 1973 and 1994 was much bigger compared to the average decline of 12 per cent for Northwest Europe.[7] This was partly due to a slightly higher sickness rate in the Netherlands compared to surrounding countries. However, more important was the greater incidence of part-time work of men and in particular women. In 1992 almost three quarters of jobs of less than 35 hours per week were held by women. In addition, agreements on worktime sharing schemes between Dutch government, employers and unions during the 1980s led to a reduction of the standard working week to 38 hours.

Input of Tangible and Intangible Capital

Table 5 and diagram 2 show the development of the physical capital stock, excluding dwellings, since 1913. The table also includes estimates of capital intensity and the capital output ratios. The new capital stock estimates are obtained from Groote, Albers and de Jong (1996), and are based on the perpetual inventory method, making use of standardised assumptions on service lives of assets and scrapping patterns across OECD countries (see appendix C).

[table 5 and diagram 2 here]

Non-residential capital stock between 1913 and 1994 increased at an average annual rate of 3.5 per cent. Between 1913 and 1929 it rose at a rate of 2.6 per cent per year, and it grew particularly rapidly from 1921 to 1929. The latter period was one of substantive industrial progress in the Netherlands (see also below). During the depression years of the 1930s the capital stock continued to increase rapidly, but in contrast to most other periods, the rate of growth in structures exceeded that of machinery and equipment. Between 1938 and 1947 there was a certain amount of net capital destruction at 0.5 per cent per year on average, but much more for machinery and equipment (-3.5 per cent per year). This can be ascribed to war damage and delayed replacement of machinery and structures during the war-years. However, the estimates of war damage are substantially lower compared to earlier figures. According to official government estimates immediately after the war, 28 per cent of industrial capital goods and 18 per cent of agricultural capital stock was destroyed. According to van Zanden and Griffiths (1989, p. 186) the destruction of industrial capital goods accounted for 17 per cent and agricultural stock for 9 per cent of the prewar stock. The present estimates suggest that the 1946 stock of gross non-residential capital was only 7 per cent below the stock in 1938. Groote, Albers and de Jong (1996) suggest that the war damage due to destruction was 8.6 per cent of the 1938 stock.[8] These findings also show that the capital stock had again reached the level of 1938-level by 1948.

For the period 1913 to 1950 as a whole we find a compound growth rate of non-residential capital stock of 2.3 per cent. This is close to Maddison's proxy estimate of 2.4 per cent, which he arrived at by simply assuming the capital stock to move parallel to real GDP (Maddison, 1991, p. 140).

During the early postwar decades, growth of the non-residential capital stock accelerated strongly, especially in machinery and equipment, but growth slowed

down after 1973 and even more so after 1979. Since 1987 the growth in machinery and equipment has accelerated again.

Table 5 shows that the movement of the capital-output ratios has not been constant during this period (see also diagram 2). For the period as a whole it rose at 0.5 per cent a year. It declined during the period of rapid growth from 1913 to 1929, but it increased during the other rapid growth period from 1947 to 1973. During the first half of the thirties the capital-output ratio showed an excessive increase due to the decreasing level of GDP. Since 1973, the capital-output ratio has continued to increase, even though the rise has slowed down since 1987.

The movement of the capital stock per hour worked gives an indication of the rate of capital deepening of the economy. For the period as a whole we found an annual compound growth rate of 3.1 per cent a year, but it was substantially lower before the World War II (except between 1929 and 1938, when unemployment rose quickly), and higher since 1947 (except for the latest period when employment increased rapidly). The rapid growth of the capital stock after 1945 went together with a significant increase in capital intensity. In contrast to what has been suggested earlier, also by ourselves[9], we find that capital deepening already started during the 1950s and not only since 1960 when real wages began to rise.

The recent literature on economic growth has emphasised the importance of investments in intangible capital, which includes investment in education ("human" capital) as well as in research and development, in accounting for economic growth.[10] Estimates on the amount of human capital that is included in labour are difficult to obtain over long periods. The best proxy presently available is to measure the number of years of schooling of the population. We make use of Maddison's estimates for 1913, 1950, 1973 and 1992 of the average number of years of primary, secondary and tertiary schooling per head of the population (Maddison, 1987, 1991, 1996).[11] After an adjustment for the increasing share of secondary and tertiary education (using weights of 1 for primary education, 1.4 for secondary education; and 2 for tertiary education), it appears that the human capital content of the population improved at almost one per cent per year on average over the century (see table 6). The total stock of human capital, i.e. the weighted trend of education per person adjusted for the trend in the total number of hours, increased at 1.4 per cent a year between 1913 and 1992, and was slightly higher for the period before 1973 than since, which was caused by the decline in the total number of hours worked.

[here table 6]

Another component of intangible capital concerns investment in R&D. A recent study of the Dutch Central Planning Bureau gives estimates of the investment in research and development by the private sector, public research institutes and universities since 1932.[12] We converted the R&D investment into 1990 guilders, and cumulated these assuming a service life of 15 years for each investment in R&D. During the period 1950-1973 the R&D stock grew at an exceptionally rapid rate of 12 per cent a year on average, but it needs to be emphasised that it started from very low levels at the end of the war. In 1950 the R&D stock was less than 10 per cent of the replacement value of the stock of machinery, which had gone up to almost 25 per cent by 1973. The R&D stock has grown more slowly since 1973, and in particular since 1987 (see also below).

Labour Productivity and Total Factor Productivity

Table 7 and diagram 3 show the development of labour and total factor productivity. Throughout the period under consideration labour productivity growth in terms of GDP per hour has been more rapid than that of GDP per person employed due to the decline in the number of hours worked per person. Table 7 shows that the gap grew especially large during the period 1913 to 1921 and from 1960 to 1987. Labour productivity grew most rapidly during the period 1947 to 1973, followed by the period 1913 to 1929 and only then by the period 1973 to 1994. In fact, labour productivity growth since 1987 has been less than half that of the productivity growth during the period 1913-1921 when the rise in GDP was approximately the same.

[here table 7 and diagram 3]

Total factor productivity calculations can be made on the basis of dividing the growth in output by a weighted average of the growth rates of the individual inputs. Table 7 and diagram 3 show three concepts of total factor productivity. The first two are essentially based on a traditional "Solow" model, which assumes that the economy is characterised by constant returns to scale.[13] Assuming a perfect market, this implies that the weights for labour and capital input can be approximated by the share of labour and capital compensation in total GDP at factor cost. Appendix Table C shows that, after

adding an imputed compensation for labour by self employed persons, the factor share of labour rose from 50 per cent in 1913 to 65 per cent in 1938, and to its highest level of 72 per cent in 1978. Since then the labour compensation share declined to around 66 per cent since the mid 1980s. Using factor shares as weights, value added per combined unit of labour and physical capital increased at 1.6 per cent over the period 1913 to 1994 as a whole. This is about 1 percentage point slower than the growth of GDP per hour worked, which accounts for the contribution of physical capital to growth. The contribution of the accumulation of human capital accounts for another 0.4 percentage points. Most striking is that the differences between the TFP growth rates for the period since 1973 and the periods 1913-1929 and 1947-1973 are much bigger with than without the adjustment for human capital investment. Compared to the period 1913 to 1929, the TFP growth rate with education for the period 1973-1994 was less than half, and compared to the period 1947 to 1973 it was only one third.

The third concept of TFP can be related to recent models of economic growth which relax the assumption on constant returns to scale. The assumption is that in particular technical change creates significant spillover effects so that the economy can continue along a path of continuous growth instead of reaching a "steady state" as predicted by the traditional models.[14] One version assumes that such increasing returns originate primarily from investment in R&D, and that the effect on the growth of output can be determined on the basis of the output elasticity of investment in R&D. Using Minne (1995), the effect of the accumulation of R&D on output was put at 5 per cent, which was added on top of the factor shares for labour and capital mentioned above. Table 7 shows that the investment R&D accounted for another 0.6 percentage points of the TFP growth from 1947 to 1973 and 0.15 percentage points of TFP growth from 1973 to 1994.

4. Explaining Underlying Causes of Variation in Growth Performance

In this section we will take a closer look at factors which may explain the variation in the long term performance of the Dutch economy. Below we focus on the behaviour of structural factors such as on employment shares, productivity, labour, capital investment and investment in human capital and R&D, and put it where possible in a comparative long run perspective.

Sectoral Performance

The productivity record for the economy as a whole can be related to the comparative performance of the individual sectors of the economy and to changes in the output and employment shares of these sectors in the total economy. Table 8 shows the change in the employment structure of the Dutch economy during the twentieth century. Table 9 presents real output and productivity growth rates for two commodity sectors, agriculture and manufacturing, since 1913.

[tables 8 and 9 here]

Productivity in agriculture has risen throughout the period, and growth was especially rapid during the period 1950 to 1973. During this period the number of regular workers in agriculture declined from almost 600 thousand to less than 300 thousand. At the same time, the production process in agriculture strongly intensified and labour productivity increased by almost 7 per cent. Since 1973 the fall in the agricultural employment share was much more moderate even though real output growth accelerated compared to the earlier period.

Although the share of the manufacturing sector in total employment remained rather stable during the prewar period and rose only slightly during the 1940s and 1950s, it was a driving force behind the growth of output and productivity throughout the period. Large branches within manufacturing were food processing (food products, beverages and tobacco products), textiles, metal products and engineering. During the 1930s the latter two branches, which produced mainly capital goods, were hit severely by the depression. Nevertheless, the period 1929-1938 witnessed an overall growth of output and productivity. Even for the 1938-1950 period as a whole output volumes in manufacturing rose, but productivity performance was negative. This can be ascribed to specific war-circumstances, such as obsolescence of machinery and equipment and lack of materials. At the same time, however, the relative price of labour was low, which may have stimulated labour intensive work practices shortly after the war.

During the 1950s and 1960s growth rates of real output and productivity in manufacturing were very high. From 1965 onwards, however, employment in manufacturing declined in absolute as well as in relative terms, particularly in "traditional" industries like textiles and shipbuilding. Only in typical processing

industries, such as basic chemicals, employment increased. After 1973 labour productivity growth slowed down to an average of 2.1 per cent per year.

The main expansion in employment shares has taken place in the services sector, namely from 38 per cent of employment in 1913 to over 70 per cent in 1992. Both market services (transport and communication, distribution and the financial sector) and non-market services (mainly health care, education and government) accounted for this rising share. However, the increase in productivity in the services sector was much slower than in agriculture and industry, which explains the lower productivity growth rates for the economy as a whole (see van Ark, 1995).

Another way to look at sectoral performance is to compare the level of output per person employed with that of neighbouring countries and with the United States. Table 10 confirms the view already outlined in table 2, showing relatively high productivity levels for the Dutch economy as a whole. The productivity advantage was biggest in the agricultural sector. After 1945 Dutch agriculture strongly specialised in relatively intensive activities such as cattle breeding, pigs, poultry and horticulture.

[here table 10]

Already before the Second World War comparative productivity in manufacturing was relatively high. In 1921 manufacturing output per person was on par with the UK level, and during the next two decades it stayed only about 10 per cent below the UK level. The relatively good productivity performance in manufacturing during the 1930s was primarily due to a process of efficiency improvement rather than output expansion. Labour cost were relatively high during the 1920s and 1930s, supported by the gold standard on which the guilder was based until 1936. As a result employers economised on labour to minimise losses, which led to a rise in average output per worker.

After the war Dutch relative productivity in manufacturing strongly improved. The performance is even better on the basis of output per hour worked, as the average number of hours per person employed in manufacturing was lower than in surrounding countries. Much of the recent labour productivity advantage in manufacturing can be explained by its relatively strong concentration in capital intensive industries, in particular in basic chemicals.[15]

Labour costs

In section 3 we have seen that participation rates of the labour force have been relatively low in the Netherlands, at least until the 1980s. Apart from a relatively large number of people who were not part of the labour force, there have also been many involuntarily unemployed in the Netherlands. As shown in the first two columns of table 11, the unemployment rate in the Netherlands has been high compared to other countries during the 1930s, but in particular since 1973. Among other things the rapid growth of the Dutch population (as shown in table 1) put considerable pressure on the labour market during times of sluggish growth.[16]

[table 11 here]

The open nature of the Dutch economy made wage constraints one of the major issues throughout this century. Already during the 1930s, wage restraint was seen as an important instrument to keep cost and price levels down. The policy to stick to the gold standard required domestic deflation to maintain international competitiveness. Indeed the rise in real wages during the period 1929-1938 was somewhat slower than in other northwest European countries, although it was not enough to offset the negative effects of an overvalued currency on the competitiveness of the Dutch economy. The policy of wage restraint was very succesful in the years immediately after the war. Real wages declined from 1938 to 1950 by 0.3 per cent per year on average.[17] The low wage levels are an important factor explaining the low levels of labour productivity immediately after the war. Labour was cheap and abundant, and there was no incentive for employers to economise on this production factor, unlike the situation in the thirties. Furthermore, international competitiveness was strenghtened by a twofold devaluation of the guilder vis a vis the dollar, in 1944 and 1949.

Table 11 shows that wage restraint policies during the first two decades after 1950 did not result in comparatively lower rates of real wage increases. Dutch real wages increased at a rate just above the Northwest European average during the 1950s and surged ahead of the Northwest European average during the 1960s. On the other hand the reduction in wage growth after 1979 is remarkable. During the most recent period, 1987 to 1994, real wage growth in the Netherlands was only 0.2 per cent compared to 1.4 per cent for

Northwest Europe, which substantially strengthened the cost competitiveness of the Dutch economy.[18]

Capital Intensity and Total Factor Productivity

Capital formation is a necessary condition for economic growth. In recent models of economic growth it has received renewed attention, given the recognition of possible increasing returns on investment, in particular in human capital such as education and R&D. Table 12 shows that non-residential capital has accounted for by far the largest share of investment. In 1921 the share of investment in non-residential capital was as high as 18.5 per cent of GDP, compared to a mere 2.8 per cent for investment in human capital. The ratio of investment to GDP then fell back to 12 per cent in 1947, rose again to 17 per cent in 1960 and stabilised at 15 per cent of GDP since the late 1970s. In contrast, the GDP-intensity of investment in education and R&D have shown a continuous rise until the late 1970s. In 1979 the investment-output ratio of education and R&D together was over half that of the physical investment output ratio.

[here table 12]

Table 13 shows that our estimates suggest a relatively high level of capital intensity in the Netherlands compared to other countries. In 1913 the replacement value of the capital stock per working hour in the Netherlands was 1.65 the level in the UK, though it was only 36 per cent of the level of capital intensity in the USA. In 1950 capital intensity in the Netherlands was still some 30 per cent above the average for France, Germany and the UK, but it declined over time because of the rapid increase in capital intensity in particular in France and Germany.

[here table 13]

The exceptionally high level of capital intensity in the Netherlands deserves some further consideration. One area of concern might be the measurement procedure of the capital stock. In developing the capital stock estimates according to the perpetual inventory method, Groote, Albers and de Jong followed Maddison (1995a) in assuming that that non-residential structures last 39 years and machinery and equipment last 14 years. These were standardised

estimates which were assumed to be the same across the six countries in Maddison's sample (France, Germany, Japan, Netherlands, UK and USA). The comparative figures for capital intensity would be affected if the actual lifetime of assets differs across countries. Further research will be required to assess the evidence on asset lives.

Unfortunately it is not possible to make reliable comparisons of capital intensity across countries for the pre-1950 period on the basis of alternative measures. From the scanty evidence we have, we may conclude that the Dutch manufacturing sector has been characterised by branches with a relatively high capital intensity. For example, evidence from the Dutch *Census of Establishments* (1930) and the *British Census of Production* of 1930 reveal higher levels of installed horse-power per worker in most Dutch manufacturing branches compared to British, especially in food processing.[19] After 1960 the nature of Dutch manufacturing changed extremely fast through the upsurge of very capital intensive branches like basic chemicals and oil refineries and the simultaneous decline of labour intensive branches like textiles. Clearly, a further breakdown of capital stock aggregates is required to get a better insight in (the change in) capital intensities between branches.

The high comparative level of capital intensity finds its counterpart in high levels of value added per person. To measure the effect of changes in capital intensity on labour productivity over time and between countries, one requires estimates of total factor productivity. This is shown in columns 3 and 4 of table 13. Here we can see that the Dutch productivity levels compared to the neighbouring countries are lower than the comparative levels of labour productivity shown in table 11. In 1913 the TFP level of the Dutch economy was at 75 per cent of the UK level, which went up to 99 per cent in 1929. After the Second World War, the Dutch TFP level was somewhat above the average of France, Germany and the UK, but was otherwise fairly similar during the subsequent period.

The explanation of the comparatively high level of capital intensity in the Netherlands remains an important issue for further research. In the long term, relative factor prices may have pushed the economy onto a path of capital deepening, but the relation with relative wage levels needs further clarification. Van Zanden and Griffiths (1989), for example, suggested that the abundant supply of labour during the 1950s held wages down. Employers therefore earned large profits which were reinvested, leading to a fall in the age of the capital stock and larger capital intensity. However, these causal links presuppose a consensus among employers and trade unions workers to exercise

restraint in wage demands and make profits available for reinvestment. This may have been characteristic for the 1950s, but it cannot be extrapolated to the whole period studied. Furthermore, labour relations in the Netherlands were not very different from other Northwest European countries.

We therefore believe that the relation between low labour costs and rapid increases in capital, was a rather unique event of the early postwar period. By the end of the 1950s and especially during the 1960s real wage levels increased very rapidly, giving rise to further capital-deepening investment substituting labour for capital. The same process can be observed following the increase in hourly wages around 1920.

Human capital and Research and Development

As mentioned above, investments in human capital and research and development have become more important throughout the period of economic growth in the Netherlands since 1913, but in particular since World War II. Table 14 shows the strong rise of enrollment in secondary and higher education during the postwar period. An important feature of the Dutch education system is its early emphasis on vocational education. Already in 1938 more than 6 per cent of the population in the age group 0-19 years was enrolled in vocational education. This percentage increased rapidly after the Second World War, although there was an important shift from lower to medium vocational schooling during the 1980s. Presently most pupils stay in full-time schooling until their twenties. This implies that a relatively large part of the population has high and relatively broad vocational qualifications at the moment they enter the labour force. In this respect, Dutch manufacturing employees are even better qualified than those in Germany, as vocational skills in the latter country are primarily concentrated in the lower intermediate segment.

[table 14 here]

Table 15 shows the change in the distribution of educational achievements of the Dutch labour force since 1960. Between 1960 and 1971, a shift took place from employees with only basic education to those with lower intermediate education. During the 1970s and 1980s, a rapid shift occurred towards upper intermediate and higher education. Workers with technical skills contribute significantly to the quality of the manufacturing labour force in terms of flexibility (i.e. the ability of workers to perform a large range of activities) and

reliability (i.e. their ability to increase the quality of products and the production process), which in turn has a positive effect on productivity.[20]

[table 15 here]

There has been some evidence that the Dutch activities in technological inventions were still rather small at the beginning of the century (Schiff, 1971), but table 12 suggests that R&D intensities increased in course of the century, even though they remained lower than in other countries. For example, in 1981 the average R&D intensity for six Northwest European countries (France, Germany, Netherlands, Norway, Sweden and the UK) was 2.4 per cent compared to 2.0 per cent for the Netherlands.

The impact of the relatively low expenditure on R&D on output growth in the Netherlands should not be exaggerated for a number of reasons. Firstly, part of the lower level of R&D intensity for the Netherlands is due to smaller expenses on the military sector than, for example, France and the UK. Secondly, much of the Dutch R&D expenditure has been spent on basic science rather than on applied research, and was to a large extent absorbed by academic institutions instead of by firms. Thirdly, business expenditure itself was concentrated in industries which were of a relatively low- or medium-tech nature, reflecting the composition of Dutch manufacturing output.[21] Fourthly, about 70 per cent of business expenditure on R&D was concentrated in the five largest firms in the Netherlands. It were these firms which were primarily responsible for the recent decline in business R&D, as their share in 1992 had declined to about 55 per cent of business R&D. Finally, much of the technology used in the Netherlands is imported rather than developed through domestic R&D. This becomes clear, for example, from the increase in the ratio of expenditure on licenses to expenditure on domestic R&D from 23 per cent in 1970 to 47 per cent in 1991. A test on the elasticity of total factor productivity with respect to the investment in domestic R&D versus the investment in foreign R&D suggests for the Netherlands an elasticity of only 0.07 for domestic R&D versus 0.15 for foreign R&D (Minne 1995, p. 76). The effect on Dutch productivity growth was the greatest for R&D expenditures in the USA (0.077) followed by Germany (0.04). In conclusion, during the most recent decades investment in R&D in foreign countries had a greater effect on productivity growth in the Netherlands than investment in the country itself.

The evidence so far suggests that human capital and R&D were not the decisive factors in explaining the relatively good productivity performance of the Dutch economy, even though high skills are a necessary requisite for good productivity performance in typical process industries such as chemicals. The clue for the rapid growth of labour productivity and the relatively high levels of value added per hour in the Netherlands since 1913 can be found in the relatively high levels of capital per hour worked. In contrast to the level of labour productivity, table 13 shows that the level of total factor productivity in the Netherlands was not substantially higher than the average for France, Germany and the UK.

5. The Main Features of Dutch Economic Growth Since 1913

The major aim of this paper has been to detect the major forces behind the economic growth process in the Netherlands since 1913. We began by showing that in comparison to other countries in Northwest Europe, the level and growth of labour productivity in the Netherlands has been relatively high. Growth of per capita income has been slower, and the comparative per capita income level even fell behind the Northwest European average in the 1980s. In contrast to what is generally suggested, when looking at the century as a whole, the Dutch economy has not shown a very strong catch-up on the US level in terms of per capita income though it did in terms of labour productivity.

As suggested in earlier studies, including our own (van Ark, de Haan and de Jong, 1994), this paper confirms that the rapid growth of the population has been one of the fundamental forces underlying the rate of growth and change in structure of the Dutch economy during the twentieth century. Van Zanden and Griffiths stressed that high population growth stimulated infrastructural outlays, generated a relatively elastic and well-trained labour supply and a relatively large domestic market. Of course this is only part of the story. During periods of depression or stagnation, such as during the 1930s and the early 1980s, the large supply of labour acted as a drag on the economy, causing high unemployment levels and stagnating overall productivity performance.

Apart from the population factor, this paper shows that there were other forces explaining the growth performance of the Dutch economy which changed over time. During the period of the First World War and the early 1920s the Netherlands could take a lead over most of the Northwest European countries because the country had not been directly involved in the hostilities, and even benefitted from its position as a neutral country. The reduction in hours worked

per person employed between 1913 and 1921 was compensated for by substantial productivity increases. The Dutch economy grew especially rapidly during the 1920s. The capital stock increased rapidly and productivity growth rates were similar to those experienced during the early post-World War II period.

This favourable development came to an end by the first half of the 1930s because of the world economic depression. Decreasing aggregate demand and a combination of inconsistent policies (monetary policy was directed at deflation whereas many domestic sectors were protected by through import restrictions, keeping up output prices) led to a decline in real output and a simultaneous rise in cost levels. Combined with an ever increasing population this resulted in a negative growth of GDP per capita. As firms faced stagnating and falling demand, cost levels had to be reduced by efficiency gains. For instance, productivity in manufacturing increased still further, which suggests a process of rationalisation and even capital deepening.

The main effect of the Second World War from an economic point of view was that it created a large disparity between the stock of capital and the size of the population. During the period 1938-1947 the Dutch population increased roughly at 1.2 per year per year on average but the capital stock fell by 0.5 per cent per year. This was unlike previous periods during which the capital stock increased much faster than the population. Relative prices of capital and labour changed substantially compared with the prewar situation. Between 1938 and 1950 real wages fell by 0.3 per cent per year on average. In 1947 the level of labour productivity, which had fallen continuously during the war years, was only 90 per cent of the 1938 level. The scope for labour productivity increases was therefore very high after 1945.

During the 1950s growth was based on a rise in investment and technological change (TFP increased at between 1.1 and 2.1 per cent per year on average, depending on the TFP concept chosen) and expanding labour input which was employed at relatively low costs. Investment in physical capital continued to increase rapidly during most of the 1960s and the 1970s. The rising labour cost during the 1960s was associated with a strong fall in total hours worked, a fall in labour force participation rates and a rapid decline in annual working hours per person. During the 1970s the fall in total hours continued, but a moderate turnaround occurred during the 1980s mainly because of a rapid rise in part-time (female) labour. On the other hand early retirement schemes and generous social security schemes prevented labour

input from expanding faster. These developments led to the expansion of the non-active population of working age.

By maintaining relatively high levels of labour productivity in combination with a significant reduction in real wage increases since the early 1980s, the Dutch economy remained competitive. The high productivity levels were partly associated with the high level of vocational education of the Dutch labour force, but can be mainly explained by the capital-intensive nature of the Dutch economy compared to neighbouring countries. In terms of total factor productivity performance, the Dutch performance has not been exceptionally high.

The analysis in this paper, which covers some 80 years of economic growth in the Netherlands, clearly shows that economic retardation since 1973 cannot be seen as a return to a "normal" growth path following the "golden years" of the period 1947-1973. The estimates for the Netherlands suggest that if one leaves out the dismal performance of the Dutch economy during the period 1929 to 1938, post-1973 growth was much worse than pre-1929 growth. Growth rates of real GDP, per capita income and productivity were all lower since 1973 than during the period 1913-1929. We also found that in contrast to the period 1921-1929, the capital-output ratio rose very rapidly during the period 1973-1987.

The second half of the 1980s and early 1990s have been characterised by some reforms in economic policy in the Netherlands. The growth of real wages was reduced more than in previous decades, and the social security system has undergone various changes with the aim to reduce the ratio of the non-active to the active population. Due to such measures and the rise in the share of the population of 20-64 year old, the Dutch economy will continue to face an increase in labour supply in coming years. GDP will therefore need to accelerate further or factor resources must be used more efficiently in order to prevent the growth rate of per capita income from slowing down in the long term.

Table 1
Population, Gross Domestic Product, GDP per Capita and GDP per Hour Worked, 1913-1994
(unweighted averages of annual compound growth rates)

	Population			Gross Domestic Product			GDP per Capita			GDP per Hour Worked		
	Nether-lands	Northwest Europe(a)	United States	Nether-lands	Northwest Europe(a)	United States	Nether-lands	Northwest Europe(a)	United States	Nether-lands	Northwest Europe(a)	United States
1913-1994	1.14	0.59	1.22	2.99	2.80	3.05	1.83	2.00	1.80	2.55	2.67	2.19
1913-1929	1.47	0.54	1.42	3.66	2.16	3.10	2.16	1.42	1.66	3.23	2.14	2.43
1913-1921	1.46	0.39	1.39	2.64	-0.43	1.44	1.16	-1.04	0.05	3.32		
1921-1929	1.48	0.69	1.45	4.69	4.83	4.79	3.17	3.95	3.29	3.14		
1929-1947	1.19	0.59	0.94	0.52	1.37	2.37	-0.66	0.49	1.42	0.36 b	1.54 b	2.51 b
1929-1938	1.23	0.54	0.73	0.33	1.54	-0.59	-0.89	0.80	-1.31	0.26	1.28	1.55
1938-1947	1.15	0.63	1.16	0.72	1.20	5.42	-0.43	0.18	4.22	0.43 b	1.74 b	3.24 b
1947-1973	1.29	0.83	1.48	5.07	4.86	3.94	3.73	3.74	2.43	4.28 c	4.41 c	2.74 c
1947-1960	1.36	0.87	1.72	5.30	5.20	3.54	3.89	3.85	1.78	4.15 c	3.90 c	2.54 c
1960-1973	1.22	0.79	1.23	4.83	4.52	4.35	3.57	3.63	3.08	4.39	4.80	2.90
1973-1994	0.65	0.36	1.01	2.07	2.00	2.49	1.42	1.59	1.47	2.38	2.32	1.08
1973-1979	0.73	0.21	1.01	2.68	2.28	2.83	1.93	1.94	1.80	3.16	2.79	1.54
1979-1987	0.55	0.24	1.01	1.22	2.01	2.56	0.67	1.74	1.53	2.56	2.16	0.82
1987-1994	0.69	0.61	1.00	2.54	1.76	2.13	1.83	1.13	1.12	1.50	2.10	1.00

(a) Includes Austria, Belgium, Denmark , Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland and the UK
(b) End year is 1950
(c) Beginning year is 1950
Sources: Population, GDP, GDP per capita and productivity for the Netherlands, see Appendix Tables A and C. Northwest Europe (except Netherlands) and USA from Maddison (1991, 1995 and 1996), with 1992-94 updates on working hours from OECD, *Employment Outlook*, July 1995.

Table 2
GDP per Capita and GDP per Hour Worked
1913-1994

	Netherlands as a % of NW-Europe(a)		Netherlands as a % of United States	
	GDP per Capita	GDP per Hour	GDP per Capita	GDP per Hour
1913	110	124	71	73
1929	123	147	77	83
1938	106	134	80	74
1950	102	115	59	53
1960	100	118	69	62
1973	100	112	74	75
1979	100	114	74	82
1987	91	118	69	95
1994	96	113	73	98

(a) Includes Austria, Belgium, Denmark , Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland and the UK

Note: In contrast to Maddison (1995), who uses Geary-Khamis PPPs, GDP is converted by multilateral EKS PPPs for OECD countries in 1990 from OECD (1992). *Purchasing Power Parities and Real Expenditures: EKS Results, 1990*, Paris.

Table 3
Annual Compound Growth Rates of GDP in Current and Constant Prices and the GDP Deflator, 1913-1994

	Real Gross Domestic Product	Gross Domestic Product in Current Prices	GDP Deflator
1913-94	2.99	7.13	4.02
1913-29	3.66	6.69	2.92
1913-21	2.64	11.95	9.08
1921-29	4.69	1.67	-2.89
1929-47	0.52	4.00	3.46
1929-38	0.33	-1.92	-2.24
1938-47	0.72	10.27	9.49
1947-73	5.07	10.50	5.17
1947-60	5.30	9.33	3.82
1950-60	*4.61*	*8.44*	*3.66*
1960-73	4.83	11.69	6.54
1973-94	2.07	6.09	3.93
1973-79	2.68	10.24	7.36
1979-87	1.22	4.24	2.98
1987-94	2.54	4.73	2.14

Source: Real GDP, see table 1. GDP in current prices 1913-1921 provided by J.P. Smits; 1921-1948 from van Bochove and Huitker (1987); from 1948 from national accounts

Diagram 1 - Growth of Labour Supply, Netherlands, 1913-95 (1913=100)

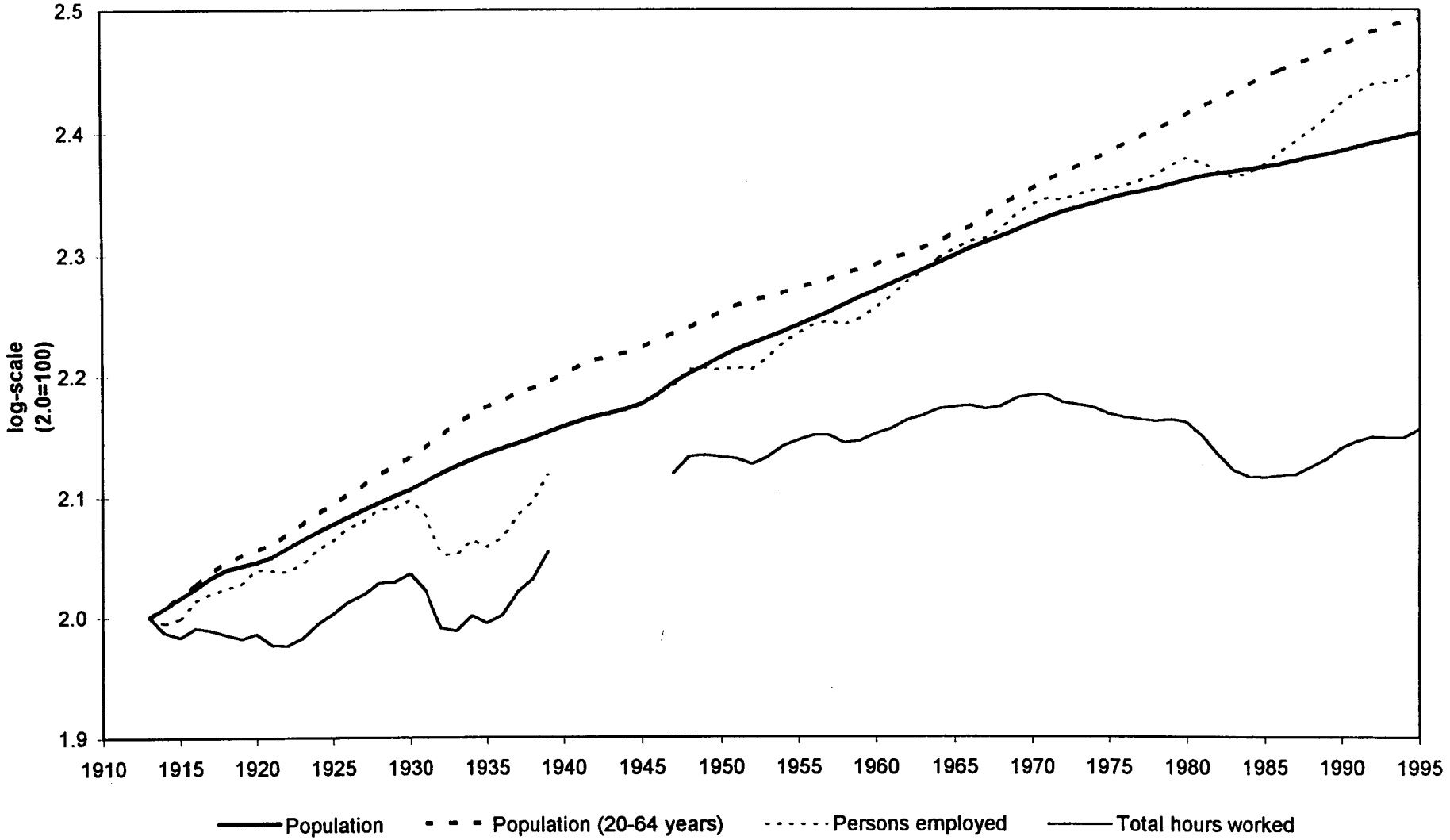

Table 4
Shares of Population in Working Age, Labour Force Participation and Female Participation in Labour Force, Netherlands, 1913-1994

	Population 20-64 years as % of Total Population	Labour Force as % of Total Population 15-64 years	Female Labour Force as % of Total Labour Force
1913	50.5	65.0	23.9 a
1921	51.8	64.4	
1929	53.5	63.3	24.0 b
1938	55.5	61.9	
1950	55.0	61.7	24.4
1960	53.1	60.6	22.3
1973	54.5	62.4	26.6
1979	56.7	62.2	29.6
1987	60.5	64.1	37.3
1994	62.5	70.2	40.7

Source: See appendix table A.1 and CBS (1989), *Negentig jaren statistiek in tijdreeksen, 1899-1989*, Den Haag.

Table 5
Annual Compound Growth Rates of Non-Residential Capital Stock, Capital Intensity and Capital-Output Ratios, 1913-1994

	Non Residential Capital Stock			Change in Capital Stock per Hour	Change in Capital-Output Ratio
	Total	Structures	Equipment		
1913-94	3.48	3.33	3.79	3.05	0.48
1913-29	2.56	1.97	3.78	2.13	-1.06
1913-21	1.27	0.40	3.14	1.94	-1.34
1921-29	3.87	3.57	4.42	2.32	-0.79
1929-47	1.54	2.37	-0.33	0.37	1.01
1929-38	3.62	4.00	2.92	3.55	3.28
1938-47	-0.51	0.77	-3.48	-2.72	-1.21
1947-73	5.91	5.12	7.61	5.38	0.80
1947-60	5.92	4.70	8.73	5.31	0.58
1950-60	*6.09*	*4.86*	*8.77*	*5.63*	*1.42*
1960-73	5.90	5.54	6.50	5.45	1.02
1973-94	2.91	3.00	2.76	3.22	0.82
1973-79	3.85	4.00	3.60	4.34	1.14
1979-87	2.31	2.87	1.35	3.66	1.07
1987-94	2.80	2.31	3.67	1.76	0.26

Notes: The estimates for the capital stock are based on the perpetual inventory method, using assumptions on asset lives and scrapping which are standardised across OECD countries and obtained from Maddison (1995a).
Sources: Groote, Albers and de Jong (1996) and appendices A to C.

Diagram 2 - Growth of Human and Physical Capital Stock and Capital-Output Ratio
(1913=100; R&D Stock: 1950=100)

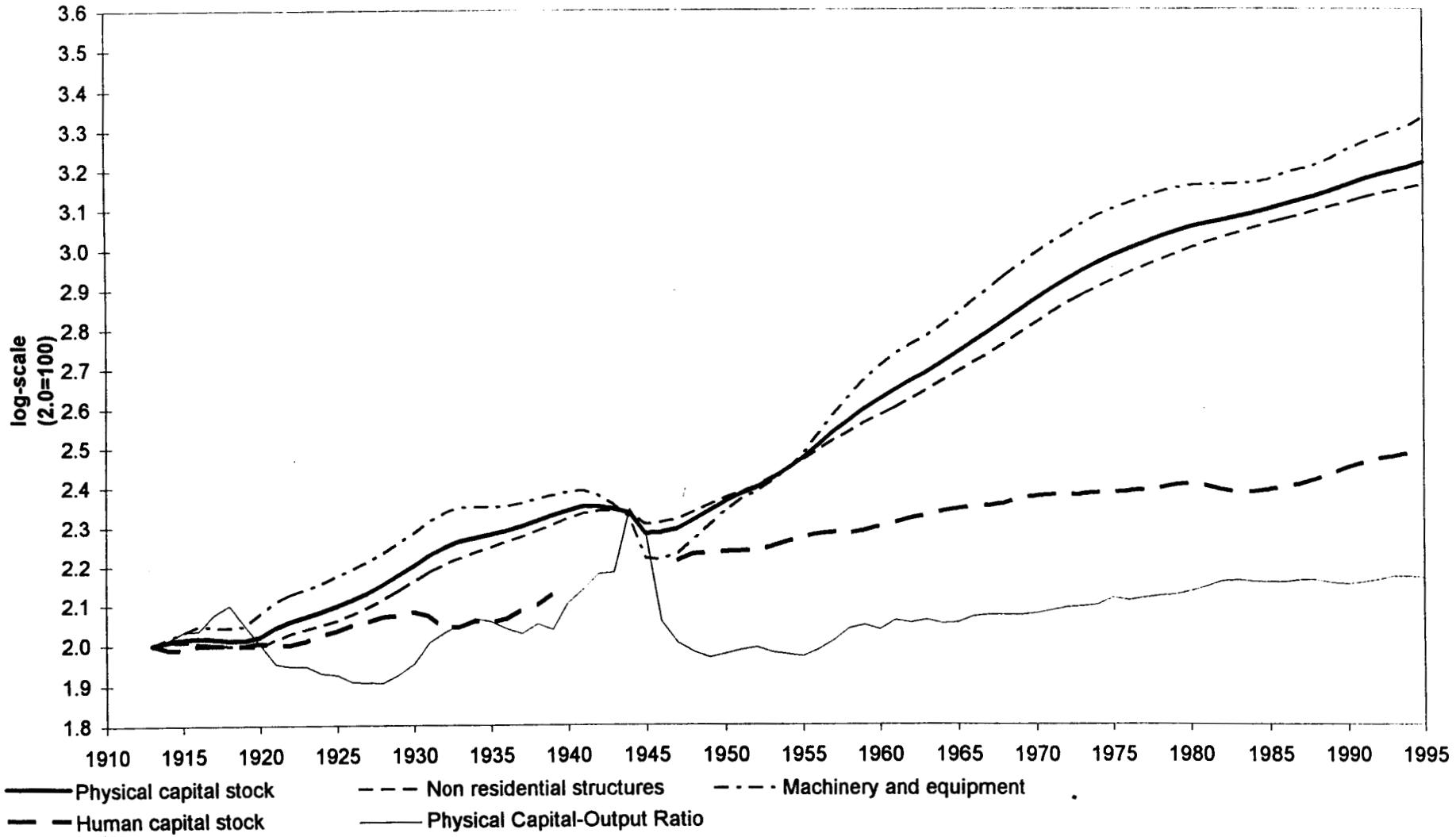

Table 6
Annual Compound Growth Rates of Education per Person and Total Stock of Human Capital, 1913-1992

	Total Number of Years of Primary Secondary and Tertairy Education per Person (15-64)	Weighted for Change in Composition (a)	Total Employment Including Schooling	Total Labour Input Including Schooling
1913-92	0.75	0.93	2.23	1.37
1913-50	0.55	0.64	1.93	1.47
1950-73	0.79	1.03	2.49	1.46
1973-92	1.08	1.39	2.50	1.06

(a) The weights for secondary education were 1.4 times primary education and for tertiary education 2 times primary education. The increments in the number of years of education per person is multiplied by 0.6 to account for the part of educational improvements which is assumed to have no effect on growth of GDP.
Sources: See Appendix C. Total stock derived by correcting for the growth rate of employment with and without an adjustment for the fall in working hours.

Table 7

Annual Compound Growth Rate of GDP, Factor Inputs and Total Factor Productivity, Netherlands, 1913-1994

	Gross Domestic Product	Persons Employed	Hours per Person	Labour Productivity		Human Capital Stock	Phyiscal Capital Stock	Stock of Research and Development	Total Factor Productivity		
				GDP per Person Employed	GDP per Hour Worked				without human capital and R&D	with human capital	with human capital and R&D
1913-1994	2.99	1.27	-0.83	1.70	2.55	1.38	3.48	--	1.59	1.21	--
1913-1929	3.66	1.31	-0.88	2.32	3.22	1.06	2.56	--	2.35	2.13	--
1913-1921	2.64	1.12	-1.76	1.50	3.29	-0.03	1.27	--	2.47	2.26	--
1921-1929	4.69	1.51	0.00	3.14	3.14	2.16	3.87	--	2.22	1.99	--
1929-1947	0.52	1.30	-0.13	-0.76	-0.64	1.81	1.54	--	-0.46	-0.73	--
1929-1938	0.33	0.14	-0.08	0.18	0.26	0.70	3.62	--	-1.20	-1.44	--
1938-1947	0.72	2.46	-0.18	-1.70	-1.53	2.93	-0.51	--	0.28	-0.03	--
1947-1973	5.07	1.40	-0.89	3.61	4.54	1.49	5.91	11.79	2.72	2.33	1.74
1947-1960	5.30	1.15	-0.57	4.11	4.70	1.52	5.92	12.41	2.83	2.47	1.85
1950-1960	*4.61*	*1.18*	*-0.73*	*3.39*	*4.15*	*1.47*	*6.09*	*12.35*	*2.14*	*1.75*	*1.13*
1960-1973	4.83	1.66	-1.21	3.12	4.39	1.46	5.90	11.18	2.61	2.19	1.63
1973-94	2.07	1.05	-1.33	1.01	2.38	1.11	2.91	3.18 a	1.40	0.82	0.67
1973-1979	2.68	0.92	-1.38	1.74	3.16	0.88	3.85	4.79	1.93	1.35	1.11
1979-1987	1.22	0.56	-1.85	0.66	2.56	0.03	2.31	2.54	1.42	0.87	0.74
1987-1994	2.54	1.73	-0.69	0.79	1.50	2.55	2.80	2.29 b	0.92	0.31	0.20

(a) 1973-92; (b) 1987-92

Note: "Human capital stock" is the average number of years per person, weighted for composition, and adjusted for the trend in labour input". TFP "without human capital and R&D" only takes into account total hours worked and the non-residential capital stock using factor shares as weights. TFP "with human capital" takes into account total hours worked and 0.6 of the rise in total years of education (adjusted for the trend in working hours) which are weighted at the labour share, and the non-residential capital stock weighted at the capital share. TFP "with human capital and R&D" is derived as TFP "with human capital" but with taking into account the change in the R&D stock using a weight of 0.05 on top of the average factor share. The latter weight is based on a calculation of the TFP elasticity to domestic R&D (0.07) from Minne (1995, p. 76). The TFP indices are calculated according to a translog index, using average factor share for each current and the preceeding year.

Sources: see Appendix Tables A to C.

Diagram 3 - Labour and Total Factor Productivity, Netherlands (1913=100)

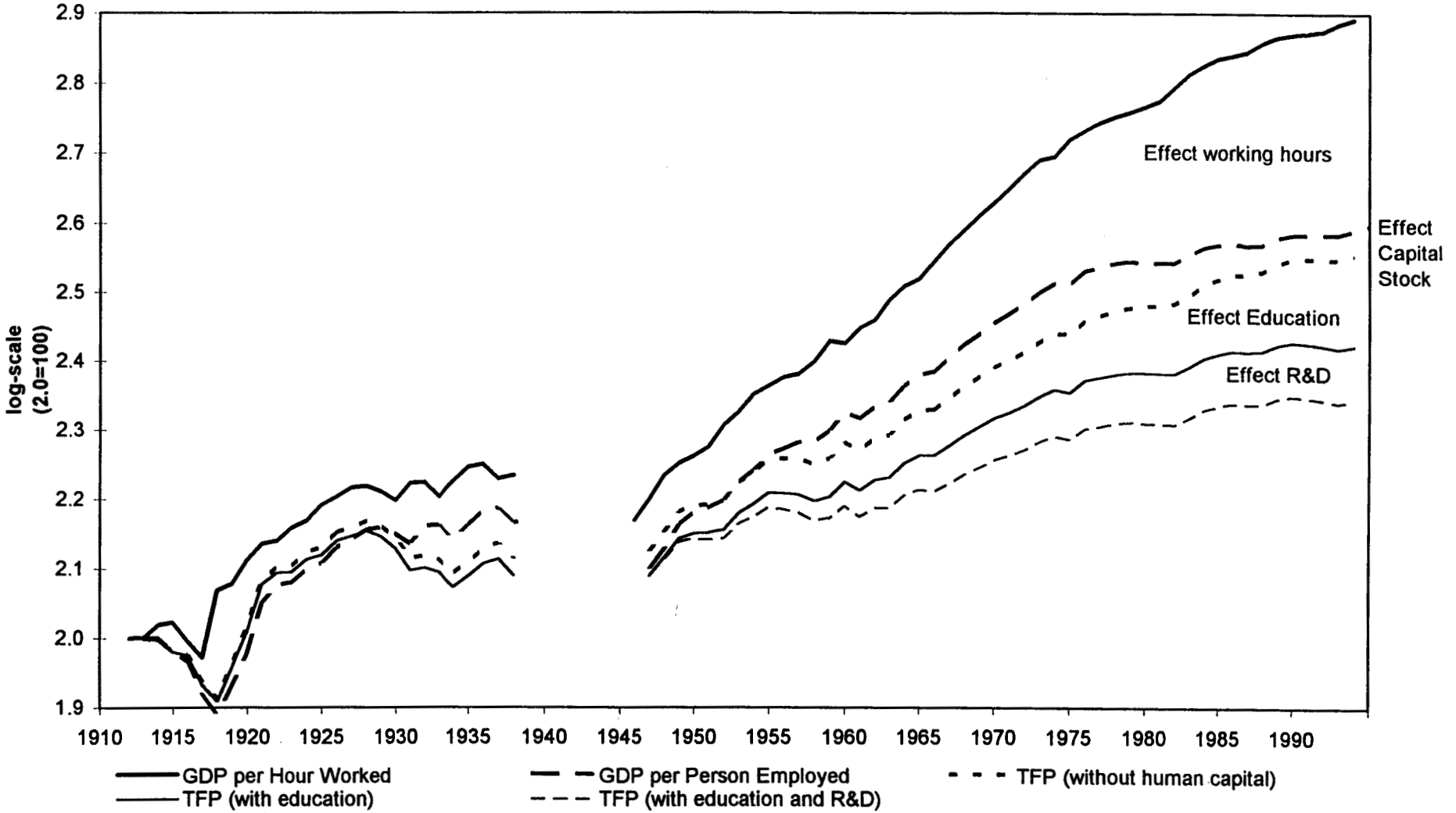

Table 8
Sectoral Shares of Employment in the Total Economy of the Netherlands, 1909-1992, in percentages

	Agri-culture	Manufac-turing	Other Industry	Market Services	Non-Market Services
1909	28.4	24.2	9.5	37.9	
1920	23.7	24.8	9.2	42.3	
1938	20.2	24.2	8.1	47.5	
1950	13.5	27.9	11.1	26.1	21.4
1960	9.5	29.2	11.7	28.9	20.7
1973	5.2	26.0	11.1	31.1	26.8
1979	5.0	21.8	10.7	33.2	29.9
1987	4.9	18.6	7.4	35.1	34.0
1992	4.4	17.7	7.1	37.9	32.9

Note: labour input 1909-1920 refers to labour force; since 1938 to persons employed, except services (1950 and 1960) which refers to "manyears".
Source: 1909 from CBS, *Negentig jaren statistiek in tijdreeksen*, Voorburg; 1920 from den Bakker en van Sorge (1991); 1938 from den Bakker, de Gijt and Keuning (1994) and den Bakker and de Gijt (1994). 1950-1992 from van Ark (1995).

Table 9
Real Output and Labour Productivity Growth in Agriculture and Manufacturing, 1913-1992, annual compound growth rates

	Real Value Added		Real Value Added per Person Employed	
	Agriculture	Manufacturing	Agriculture	Manufacturing
1913-1929	2.1	4.9	1.8	2.7
1913-1921	1.0	3.1	0.7	2.1
1921-1929	3.2	6.8	2.8	3.3
1929-1950	1.1	2.2	1.1	0.4
1929-1938	1.3	2.5	1.0	1.8
1938-1950	0.9	2.0	1.2	-0.6
1950-1973	3.2	6.9	6.5	6.2
1950-1960	3.5	7.6	6.0	5.9
1960-1973	3.0	6.4	6.9	6.4
1973-1992	4.3	1.3	4.0	2.1
1973-1979	3.6	0.0	3.3	1.9
1979-1987	4.2	1.6	3.8	3.0
1987-1992	5.2	2.3	5.1	1.1

Sources and Notes: 1950-1992 from van Ark (1995). 1913-1950: for manufacturing from De Jong (forthcoming). 1913-1921: agricultural output provided by JP Smits; agricultural output 1921-1950 from van der Meer and Yamada (1990) and Knibbe (1993); agricultural employment are regular workers from van der Meer (1987).

Table 10
Value Added per Person Employed in Agriculture and Manufacturing, 1913-1992, (Netherlands as a % of UK for 1913-38; Netherlands as % of Germany/France/UK and of the USA for 1950-92)

	France/Germany/UK = 100[a]		United States = 100	
	Agri-culture	Manufac-turing	Agri-culture	Manufac-turing
1913		*78*[a]		
1921		*104*[a]		
1929		*91*[a]		
1938		*89*[a]		
1950	145	93	33	38
1960	167	102	40	56
1973	173	123	65	82
1979	169	116	74	87
1987	154	126	70	83
1992	149	116	80	84

[a] Netherlands as % of the UK only

Sources: The figures for the period 1913-1938 are based on two productivity comparisons between Netherlands and the UK for the years 1913 (Burger, 1994) and 1935 (De Jong, forthcoming). The comparative productivity levels (1950-1992) are based on binary comparisons between each country and the United States. The average productivity for France, Germany and the UK is an unweighted average. See Maddison and van Ark (1994) and van Ark (1995).

Table 11
Average Unemployment Rates and Growth of Real Wages in the Netherlands and Northwest Europe, 1913-1994

	Average Unemployment as % of Labour Force		Rate of Growth of Real Gross Hourly Wages	
	Netherlands	NW-Europe	Netherlands	NW-Europe
1913-1929	2.9		1.8	1.7
1913-1921	3.3		2.8	2.8
1921-1929	2.4	4.4	0.8	0.6
1929-1950			-0.1	0.9
1929-1938	8.0	7.2	0.2	0.7
1938-1950			-0.3	1.2
1950-1973	2.2	2.1	6.2	5.0
1950-1960	2.5	2.6	4.4	4.0
1960-1973	1.8	1.7	7.6	5.9
1973-1994	7.7	5.6	1.7	2.2
1973-1979	5.6	3.5	4.1	4.2
1979-1987	9.6	6.1	1.2	1.4
1987-1994	7.6	6.7	0.2	1.4

Note: NW European average for unemployment are unweighted averages for 11 countries mentioned in table 1; real gross wages (i.e. mostly hourly compensation of employees including tax and premiums paid by employees and employers deflated by the consumer price index) are unweighted averages for to Belgium, Denmark, France, Germany, Netherlands, Norway, Sweden and the UK. Real wages for the period 1913-50 are mostly industrial wages.
Sources: unemployment rates from Maddison (1991) except for 1913-1921 from van der Bie (1995). Wages: 1913-38 for NW-Europe from Williamson (1995); 1913-50 for the Netherlands from Schrage et. al. (1989) and CBS (1994); 1950-94 from US Dept. of Labor (1995).

Table 12
Intensity of Investment in Non-Residential Capital Stock, Education and R&D, and the Stock of R&D, Netherlands, 1913-1992

	Intensity (Investment as % of GDP)			Stock (1990 mln. DFL)	
	Non-residential Capital	Education	R&D	Non-residential Capital	Research and Development
1913	12.8			97,841	
1921	18.5	2.8 a		108,197	
1929	14.6	3.5 a		146,565	
1938	13.5	3.3 a	0.2	201,849	778
1947	11.8	2.6 a	0.5	192,833	4,189
1960	17.3	4.5 a	1.5	407,059	19,166
1973	16.1	6.6	1.9	857,484	75,977
1979	14.8	6.5	1.9	1,075,500	100,619
1987	15.2	5.2	2.3	1,290,972	123,005
1992	15.0	4.6 b	1.9	1,492,323	137,763

(a) includes fixed investment (mainly structures) in education.
(b) 1991
Note: Investment in education from 1921 to 1960 includes fixed investment, and from 1973 onwards only current expenses. R&D refers to R&D by private firms, (semi-)public research institutes and universities. R&D stock is obtained on the basis of cumulating investment in R&D from 1932 onwards (deflated at GDP deflator) assuming a "service life" of 15 years.
Sources: Investment in non-residential capital stock from Groote, Albers and de Jong (1996). Investment in education and R&D from Minne (1995); For calculation methods of stock see appendix B.

Table 13
Capital Intensity and Total Factor Productivity as a Percentage of the Average for France/Germany/UK (before 1913: only UK) and the United States, 1913-1992

	Capital Stock per Hour Worked		GDP per Hour Worked		Total Factor Productivity	
	as % of France/Ger-UK[a]	as % of USA	as % of France/Ger-many/UK[a]	as % of USA	as % of France/Ger-many/UK[a]	as % of USA
1913	*166*[a]	36	*88*[a]	73	*75*[a]	99
1929	*170*[a]	36	*116*[a]	83	*99*[a]	113
1938	*214*[a]	38	*109*[a]	74	*87*[a]	99
1950	131	34	115	53	106	74
1960	153	47	114	62	100	78
1973	132	71	108	75	99	83
1979	124	80	107	82	101	88
1987	122	95	110	95	104	96
1992	115[b]	93	106	97	102	99

[a] only UK; [b] France and Germany refer to 1991.
Note: For the calculation of TFP levels, we made use of proximate shares for labour and capital, i.e. 0.7 and 0.3 respectively.
Sources: Capital stock figures for the Netherlands from Groote, Albers and de Jong (1996); see also appendix B. For France, Germany, UK and USA from Maddison (1995a). GDP per hour, see table 2.

Table 14
Pupils in General and Vocational Education as % of Population 5-24 Years
Netherlands, 1909-1991

	General Schooling			Vocational Schooling		
	Primary Schooling	Secondary Schooling	Universities	Lower	Medium	Higher
1910	38.7			1.7	1.1	
1920	37.7			2.7	1.2	
1930	38.8	4.0	0.4	4.1	1.4	
1938	35.8	5.5	0.4	4.8	1.5	
1947	35.1	7.3	0.8	6.0	1.9	
1960	35.6	12.6	1.0	13.0	1.6	1.6
1973	31.1	16.8	2.4	11.9	3.2	3.1
1979	29.0	19.2	3.2	11.5	4.0	4.2
1987	32.4	19.3	4.1	6.8	11.3	4.9
1991	33.9	18.8	4.6	5.5	12.2	6.1

Note: Nurseries are excluded from primary education. Secondary general education includes special schools. From 1960 onwards vocational education includes parttime education.
Source: CBS (1994)

Table 15
Educational Distribution of the Dutch Labour Force, 1960, 1971 and 1987

	1960	1971	1987
Only basic education	56	40	17
Lower intermediate education	33	40	23
Upper intermediate education	7	12	40
Higher education	3	9	21

Note: lower intermediate education is lower vocational education and lower secondary education (MULO and MAVO). Upper intermediate education is intermediate vocational and higher secondary education (HBS, Gymnasium, HAVO, MBO and VWO). Higher education is higher vocational education (HBO) and university.
Source: 1960 and 1971 from population census; 1987 from CBS, revised estimates of the "Enquête Beroepsbevolking 1987" in CBS, *Sociaal-Economische Maandstatistiek*, 1990, no. 4.

Appendix A - Population, Employment and Working Hours

Estimates of number of persons employed

Compared to our previous work (van Ark, de Haan and de Jong, 1994; van Ark, 1995) we significantly adjusted our pre-1973 estimates of the number of persons employed for the Netherlands. In 1987 the CBS undertook a complete overhaul of its reporting system on employment, which implied in particular a better estimation of persons working less than 20 hours per week. The estimates for the period since 1987 are now reported annually in the *Arbeidsrekeningen*. Recently the CBS has begun to revise its employment estimates backwards to 1950, following the same concepts as those which are used in the *Arbeidsrekeningen*. For this paper we used the recent CBS estimates which gives a consistent series for the period 1950 to 1994 (see Appendix Table A.1).

Given the tentative nature of the recent CBS estimates, we compare those with alternative estimates in Appendix Table A.2. For the period 1973-1987, van Ark (1995) used a combination of statistics from the *Statistiek Werkzame Personen* and the *Labour Force Survey* in order to get as close as possible to the post-1987 concept of employment. Van Ark's estimate took into account persons working less than 15 hours per week, self-employed and the armed forces. The US Bureau of Labor Statistics (BLS) made similar kind of estimates for this period (which were adopted by Maddison, 1991, 1995 and 1996). As can be seen from Appendix Table A.2 the estimates from BLS and van Ark differ little from the CBS estimates for the period after 1973.

However, the differences for the various series are much bigger for the period 1950 to 1973. The series which has been used most frequently so far is a series of man-years, for which part-time employment is adjusted to full-time equivalents. This adjustment to obtain a labour volume series seems to be only partial, as no correction is made for changes in working hours (CBS, 1967; see also Maddison, 1982a). The BLS used the man-year series to backdate their employment estimate from 1973 to 1950, and these estimates were adopted by Maddison (1991, 1995, 1996) and van Ark (1995). This explains their comparatively high estimates of employment for 1950 (4,120 to 4,156) and 1960 (4,606 to 4,651).

For 1947 we adopted the census estimate of the working labour force (CBS, 1967, p. 27), but this figure is very unreliable. For 1920-1939 we made use of estimates from Den Bakker and de Gijt (1994), and for 1913-1921 we linked the estimate by van der Bie (1995) to that of Den Bakker and de Gijt in 1920.

The result of using the recent CBS employment estimates compared to our earlier studies is that we find a faster growth in employment from 1950 to 1973, and especially from 1960 to 1973 when the share of part-time labour began to rise substantially. As a result the annual growth of value added per hour for the period 1960 to 1973 is adjusted downwards from 5.21 per cent in our earlier work (van Ark, de Haan and de Jong, 1994) to 4.39 per cent in the present study.

Appendix Table A.1
Population, Employment and Hours Worked, Netherlands, 1913-1994

	Population (midyear estimate) (1,000)	Population (20-64 years) (1,000)	Number of Persons Employed (1,000)	Hours Worked per Person Employed	Total Hours Worked (mln.)
1913	6,164	3,113	2,381	2,605	6,203.8
1914	6,277	3,176	2,354	2,559	6,023.1
1915	6,395	3,242	2,374	2,514	5,969.6
1916	6,516	3,317	2,460	2,470	6,076.2
1917	6,654	3,400	2,492	2,426	6,046.5
1918	6,752	3,464	2,516	2,384	5,997.7
1919	6,805	3,505	2,540	2,342	5,947.6
1920	6,848	3,540	2,610	2,300	6,004.3
1921	6,921	3,585	2,603	2,260	5,883.9
1922	7,032	3,650	2,598	2,260	5,871.5
1923	7,150	3,725	2,635	2,260	5,955.1
1924	7,264	3,799	2,709	2,260	6,122.3
1925	7,366	3,867	2,761	2,260	6,239.9
1926	7,471	3,945	2,828	2,260	6,391.3
1927	7,576	4,015	2,864	2,260	6,472.6
1928	7,679	4,093	2,929	2,260	6,619.5
1929	7,782	4,163	2,935	2,260	6,633.1
1930	7,884	4,234	2,984	2,258	6,738.5
1931	7,999	4,319	2,893	2,256	6,527.9
1932	8,123	4,411	2,692	2,255	6,069.5
1933	8,237	4,506	2,680	2,253	6,037.7
1934	8,341	4,588	2,762	2,251	6,217.5
1935	8,434	4,656	2,726	2,249	6,131.6
1936	8,516	4,709	2,770	2,248	6,225.7
1937	8,599	4,772	2,897	2,246	6,506.0
1938	8,685	4,820	2,973	2,244	6,671.4
1939	8,782	4,874	3,135	2,244	7,034.9
1940	8,879	4,946			
1941	8,966	5,021			
1942	9,042	5,082			
1943	9,103	5,116			
1944	9,175	5,156			
1945	9,262	5,205			
1946	9,424	5,277			
1947	9,630	5,345	3,700	2,208	8,169.6
1948	9,800	5,410	3,819	2,208	8,433.1
1949	9,956	5,486	3,833	2,208	8,462.5
1950	10,114	5,563	3,816	2,208	8,425.7
1951	10,264	5,635	3,834	2,192	8,403.3
1952	10,382	5,689	3,821	2,176	8,313.2
1953	10,494	5,730	3,897	2,160	8,416.3
1954	10,616	5,775	4,009	2,144	8,594.5
1955	10,751	5,827	4,089	2,128	8,701.6
1956	10,888	5,880	4,158	2,112	8,783.4
1957	11,026	5,932	4,187	2,097	8,779.7
1958	11,187	5,996	4,157	2,081	8,652.7
1959	11,348	6,048	4,207	2,066	8,692.4

	Population (midyear estimate) (1,000)	Population (20-64 years) (1,000)	Number of Persons Employed (1,000)	Hours Worked per Person Employed	Total Hours Worked (mln.)
1960	11,486	6,099	4,293	2,051	8,804.9
1961	11,639	6,169	4,390	2,026	8,895.0
1962	11,806	6,222	4,514	2,002	9,035.7
1963	11,966	6,294	4,609	1,978	9,114.3
1964	12,127	6,367	4,724	1,954	9,228.8
1965	12,292	6,466	4,801	1,930	9,265.8
1966	12,455	6,539	4,876	1,907	9,296.7
1967	12,597	6,689	4,901	1,884	9,231.4
1968	12,730	6,811	4,987	1,861	9,279.8
1969	12,878	6,928	5,126	1,838	9,423.2
1970	13,039	7,028	5,218	1,816	9,476.3
1971	13,194	7,138	5,281	1,794	9,474.8
1972	13,329	7,238	5,273	1,772	9,346.0
1973	13,439	7,324	5,315	1,751	9,306.6
1974	13,545	7,423	5,363	1,727	9,261.0
1975	13,666	7,530	5,369	1,703	9,143.4
1976	13,774	7,645	5,409	1,680	9,084.4
1977	13,856	7,746	5,460	1,656	9,043.5
1978	13,942	7,849	5,522	1,633	9,020.0
1979	14,038	7,960	5,616	1,611	9,046.9
1980	14,150	8,080	5,691	1,581	8,997.8
1981	14,247	8,192	5,651	1,552	8,769.0
1982	14,313	8,302	5,562	1,523	8,470.9
1983	14,367	8,419	5,499	1,495	8,219.8
1984	14,424	8,539	5,533	1,467	8,117.3
1985	14,491	8,666	5,625	1,440	8,099.3
1986	14,572	8,772	5,754	1,413	8,131.5
1987	14,665	8,872	5,872	1,387	8,144.5
1988	14,760	8,974	6,001	1,377	8,263.7
1989	14,849	9,088	6,140	1,367	8,394.5
1990	14,951	9,195	6,315	1,357	8,571.9
1991	15,070	9,328	6,443	1,348	8,683.0
1992	15,178	9,441	6,542	1,338	8,753.2
1993	15,286	9,538	6,571	1,329	8,735.8
1994	15,389	9,618	6,621	1,321	8,746.0

Source: Population (midyear estimate) from Maddison (1995); Ratio of population 20-64 years to total population from CBS (1959 and 1994); Employment: 1950-94 are all employed persons provided by CBS based on concepts and procedures of *Arbeidsrekeningen* (CBS, 1993). 1947 from CBS (1967) and interpolated for 1947-1950 on the basis of man-year estimates from CBS. 1920-39 from den Bakker and van Sorge (1991) and den Bakker and de Gijt (1994); 1913-20 from van der Bie (1995).
Annual hours per person employed for 1913, 1929, 1938, 1950, 1960, 1973, 1979, 1987 and 1992 from Maddison (1987, 1991 and 1995), with logarithmic interpolations for intermediate years except for the period 1913-1929, where all the decline in hours per person was assumed to have taken place between 1913 and 1920.

Appendix Table A.2
Alternative Estimates of Persons Employed in the Netherlands, 1913-1992

	Our Estimate	van der Bie (1995)	Oomens and Den Bakker (1994)	CBS (1994) "jobs"	CBS (1994) "man-years" Nat. Acc.	Bureau of Labor Statistics	Maddison (1982, 1987)	Maddison (1991, 1995, 1996)	Van Ark (1995)
1913	2,381	2,372					2,330	2,330	
1920	2,610	2,593	2,618						
1921	2,603								
1929	2,935						3,023	3,023	
1930	2,984		2,998						
1938	2,973						3,169	3,169	
1947	3,700								
1950	3,816			3,962		4,156	3,625	4,120	4,147
1960	4,293		4,202	4,452		4,606	4,101	4,630	4,651
1973	5,315			5,507		5,160	4,731	5,150	5,214
1979	5,616			5,818		5,460	4,915		5,577
1987	5,872			6,082	5,872	5,940		5,864	5,872
1990	6,315		6,233	6,559	6,315	6,350		6,356	6,315
1992	6,542			6,777	6,542	6,550		6,655	6,528

Sources: see references.

Appendix Table B.1
Non-residential Capital Stock, Human Capital Stock and Stock of Research and Development, Netherlands, 1913-1994

	Non-residential capital stock			Years of Education			Stock of Research and Development (mln. 1990 DFL)
	Machinery and Equipment (mln. 1990 DFL	Structures (mln. 1990 DFL)	Total (mln. 1990 DFL)	per person 15-64 years	for Total Employment not adjusted for trend in hours	for Total Employment adjusted for trend in hours	
1913	28,983	68,857	97,841	6.4	15,280	15,280	
1914	30,153	69,850	100,004	6.5	15,197	14,929	
1915	31,146	70,077	101,224	6.5	15,429	14,891	
1916	32,383	69,703	102,086	6.5	16,088	15,254	
1917	32,183	69,299	101,482	6.6	16,400	15,276	
1918	32,028	68,559	100,587	6.6	16,665	15,249	
1919	32,356	68,214	100,570	6.7	16,929	15,218	
1920	34,685	68,094	102,779	6.7	17,508	15,461	
1921	37,109	71,088	108,197	6.8	17,576	15,248	
1922	38,797	73,471	112,268	6.8	17,651	15,313	
1923	39,997	75,257	115,254	6.8	18,016	15,630	
1924	41,486	77,170	118,655	6.9	18,640	16,172	
1925	43,252	79,192	122,444	6.9	19,119	16,587	
1926	45,008	81,923	126,931	7.0	19,708	17,098	
1927	46,849	85,179	132,029	7.0	20,086	17,426	
1928	49,360	89,349	138,709	7.1	20,673	17,935	
1929	52,457	94,108	146,565	7.1	20,848	18,087	
1930	55,674	99,499	155,173	7.1	21,331	18,491	
1931	59,742	105,198	164,940	7.2	20,813	18,028	
1932	62,787	109,936	172,723	7.2	19,490	16,869	
1933	64,864	114,004	178,868	7.3	19,527	16,887	
1934	65,082	117,941	183,024	7.3	20,253	17,501	
1935	64,881	121,781	186,662	7.4	20,116	17,370	
1936	65,162	125,504	190,667	7.4	20,571	17,749	
1937	66,296	129,334	195,630	7.5	21,652	18,666	
1938	67,958	133,891	201,849	7.5	22,362	19,263	
1939	69,582	138,821	208,403	7.6	23,731	20,442	
1940	70,698	143,700	214,399	7.6			
1941	71,505	148,502	220,007	7.7			
1942	69,645	150,569	220,215	7.7			
1943	66,060	150,998	217,057	7.8			
1944	60,976	150,500	211,476	7.8			
1945	48,064	139,795	187,860	7.9			
1946	47,738	140,791	188,529	7.9			
1947	49,387	143,446	192,833	8.0	29,469	24,978	4,189
1948	53,417	149,248	202,665	8.0	30,614	25,948	4,738
1949	58,054	155,560	213,615	8.1	30,916	26,205	5,332
1950	63,199	162,075	225,274	8.1	30,978	26,257	5,984
1951	67,638	168,226	235,864	8.2	31,444	26,456	6,681
1952	70,693	173,538	244,232	8.3	31,659	26,441	7,463
1953	74,990	182,293	257,283	8.4	32,620	27,043	8,408
1954	80,401	191,331	271,732	8.5	33,901	27,899	9,459
1955	87,465	201,639	289,103	8.5	34,933	28,537	10,682
1956	98,046	213,363	311,409	8.6	35,886	29,101	11,978
1957	110,461	226,260	336,721	8.7	36,507	29,387	13,275
1958	121,780	237,516	359,296	8.8	36,618	29,259	14,722
1959	134,933	249,872	384,806	8.9	37,438	29,695	16,623

	Non-residential capital stock			Years of Education			Stock of Research and Development (mln. 1990 DFL)
	Machinery and Equipment (mln. 1990 DFL	Structures (mln. 1990 DFL)	Total (mln. 1990 DFL)	per person 15-64 years	for Total Employment not adjusted for trend in hours	for Total Employment adjusted for trend in hours	
1960	146,544	260,516	407,059	9.0	38,596	30,387	19,166
1961	157,139	273,006	430,144	9.1	39,872	31,013	22,021
1962	165,899	287,028	452,927	9.2	41,419	31,827	25,224
1963	174,320	301,775	476,095	9.3	42,725	32,433	28,733
1964	185,780	318,928	504,709	9.4	44,240	33,177	32,552
1965	198,671	336,516	535,187	9.5	45,423	33,652	36,639
1966	214,107	354,782	568,889	9.6	46,605	34,111	41,053
1967	229,720	374,596	604,316	9.7	47,325	34,219	45,890
1968	246,714	396,925	643,639	9.8	48,649	34,751	50,906
1969	263,027	421,637	684,664	9.9	50,518	35,650	55,671
1970	281,507	447,454	728,961	10.0	51,953	36,219	60,573
1971	298,057	475,135	773,192	10.1	53,119	36,584	65,781
1972	314,271	500,805	815,076	10.2	53,583	36,458	71,044
1973	332,331	525,153	857,484	10.3	54,564	36,676	75,977
1974	349,109	548,686	897,795	10.4	55,801	36,990	80,735
1975	363,465	572,214	935,679	10.5	56,619	37,015	85,403
1976	374,568	596,106	970,674	10.7	57,813	37,273	89,859
1977	388,991	618,948	1,007,939	10.8	59,147	37,607	93,723
1978	400,474	641,944	1,042,418	11.0	60,628	38,017	97,238
1979	410,946	664,554	1,075,500	11.1	62,494	38,646	100,619
1980	417,226	687,583	1,104,810	11.3	64,185	38,956	103,744
1981	418,930	709,861	1,128,791	11.4	64,596	38,479	106,407
1982	419,111	731,144	1,150,255	11.6	64,439	37,674	108,813
1983	421,355	752,012	1,173,366	11.7	64,571	37,051	111,165
1984	422,815	774,022	1,196,837	11.9	65,849	37,084	113,630
1985	431,335	793,893	1,225,228	12.1	67,849	37,503	116,375
1986	445,661	813,722	1,259,383	12.2	70,344	38,161	119,489
1987	457,591	833,381	1,290,972	12.4	72,757	38,739	123,005
1988	468,468	854,508	1,322,976	12.6	75,361	39,838	126,656
1989	487,616	875,020	1,362,636	12.7	78,150	41,016	129,925
1990	511,918	896,603	1,408,521	12.9	81,645	42,543	132,877
1991	532,517	920,100	1,452,617	13.1	84,615	43,774	135,312
1992	552,210	940,113	1,492,323	13.3	87,270	44,824	137,763
1993	569,440	959,373	1,528,814	13.6	89,040	45,441	
1994	589,095	977,633	1,566,729	13.8	91,133	46,212	

Notes: The estimates of the non-residential capital stock are based on the perpetual inventory method, using assumptions on asset lives (14 years for machinery and equipment and 39 years for structures) which are standardised across OECD countries and make use of rectangular scrapping (see Maddison, 1995a).
As the first estimates on R&D expenditure were for 1932, and assuming a "life time" of 15 years for each investment, we have a completely cumulated stock by 1947.
Sources: Non-residential capital stock from Groote, Albers and de Jong (1996). Years of education per person of the population (15-64) for 1913, 1950, 1973, 1987 and 1992 from Maddison (1987, 1991, 1996), with logarithmic interpolations for intermediate years. Total employment and trend in annual hours from appendix table A.1. Stock of R&D: Investment in R&D in current prices by firms, public research institutes and universities from Minne (1995), which was converted into 1990 prices with the GDP deflator (see sources appendix table C.1) and cumulated into a stock assuming a service life of 15 years for each investment.

Appendix Table C.1
GDP, GDP per Capita, Labour and Total Factor Productivity
Netherlands, 1913-1994

	Gross Domestic Product (mln. 1990 DFL)	GDP per Capita (1990 DFL)	GDP per Person Employed (1990 DFL)	GDP per Hour Worked (1990 DFL)	Labour Compensation as % of GDP at Factor Cost	Total Factor Productivity (1950=100)		
						without human capital and R&D	with human capital	with human capital and R&D
1913	50,744	8,232	21,308	8.18	50.0	64.5	70.6	
1914	49,374	7,866	20,978	8.20	51.2	64.1	70.1	
1915	51,048	7,983	21,499	8.55	52.4	61.9	67.5	
1916	52,419	8,045	21,307	8.63	53.7	61.1	66.6	
1917	49,069	7,374	19,691	8.12	55.0	55.8	60.6	
1918	46,025	6,816	18,292	7.67	56.3	52.9	57.3	
1919	57,036	8,382	22,457	9.59	57.7	59.5	64.3	
1920	58,762	8,581	22,514	9.79	59.1	67.0	72.3	
1921	62,364	9,011	23,954	10.60	60.5	78.4	84.5	
1922	65,764	9,352	25,313	11.20	60.2	81.6	87.7	
1923	67,388	9,425	25,574	11.32	60.0	82.0	88.0	
1924	72,310	9,955	26,693	11.81	59.7	85.7	91.7	
1925	75,355	10,230	27,293	12.08	59.5	87.2	93.1	
1926	81,393	10,895	28,781	12.74	59.2	91.6	97.6	
1927	84,793	11,192	29,607	13.10	59.0	93.3	99.2	
1928	89,309	11,630	30,491	13.49	58.7	95.1	100.8	
1929	90,020	11,568	30,671	13.57	58.5	93.5	98.9	
1930	89,817	11,392	30,099	13.33	59.2	90.1	95.1	
1931	84,337	10,543	29,152	12.92	59.8	84.0	88.5	
1932	83,169	10,239	30,895	13.70	60.5	84.8	89.1	
1933	83,017	10,079	30,977	13.75	61.2	83.7	87.8	
1934	81,495	9,770	29,506	13.11	61.9	79.9	83.6	
1935	84,539	10,024	31,012	13.79	62.6	83.0	86.6	
1936	89,868	10,553	32,443	14.43	63.3	86.8	90.3	
1937	94,993	11,047	32,790	14.60	64.0	88.4	91.8	
1938	92,709	10,675	31,184	13.90	64.7	83.8	86.8	
1939	99,002	11,273	31,579	14.07				
1940	87,229	9,824						
1941	82,611	9,214						
1942	75,507	8,351						
1943	73,680	8,094						
1944	49,425	5,387						
1945	50,592	5,462						
1946	85,402	9,062						
1947	98,849	10,265	26,716	12.10	66.4	86.0	86.6	88.2
1948	109,404	11,164	28,645	12.97	66.1	91.9	92.3	93.4
1949	119,045	11,957	31,061	14.07	65.8	98.0	98.3	98.9
1950	123,308	12,192	32,313	14.63	65.6	100.0	100.0	100.0
1951	125,896	12,266	32,837	14.98	65.3	100.6	100.2	99.7
1952	128,433	12,371	33,612	15.45	65.0	102.1	101.3	100.2
1953	139,597	13,303	35,822	16.59	64.7	108.3	107.0	105.1
1954	149,086	14,044	37,188	17.35	64.4	112.0	110.3	107.7
1955	160,148	14,896	39,166	18.40	64.2	116.9	114.6	111.2
1956	166,034	15,249	39,931	18.90	63.9	117.2	114.5	110.4
1957	170,703	15,482	40,770	19.44	63.6	117.1	113.9	109.3
1958	170,195	15,214	40,942	19.67	63.3	114.9	111.4	106.3
1959	178,517	15,731	42,433	20.54	63.1	117.2	113.2	107.3

	Gross Domestic Product (mln. 1990 DFL)	GDP per Capita (1990 DFL)	GDP per Person Employed (1990 DFL)	GDP per Hour Worked (1990 DFL)	Labour Compensation as % of GDP at Factor Cost	Total Factor Productivity (1950=100)		
						without human capital	with education	with education and R&D
1960	193,538	16,850	45,082	21.98	62.8	123.6	118.9	111.9
1961	194,096	16,676	44,213	21.82	63.4	120.6	115.5	107.9
1962	207,391	17,567	45,944	22.95	64.0	125.3	119.6	110.9
1963	214,901	17,959	46,626	23.58	64.6	126.9	120.6	111.0
1964	232,712	19,190	49,262	25.22	65.3	133.7	126.6	115.8
1965	244,890	19,923	51,008	26.43	65.9	137.5	129.7	118.0
1966	251,639	20,204	51,608	27.07	66.5	138.1	129.7	117.3
1967	264,884	21,028	54,047	28.69	67.2	143.2	133.9	120.4
1968	281,883	22,143	56,524	30.38	67.8	148.8	138.7	124.0
1969	300,049	23,299	58,535	31.84	68.5	153.8	142.7	127.0
1970	317,099	24,319	60,770	33.46	69.2	158.9	146.8	130.1
1971	330,496	25,049	62,582	34.88	69.8	162.7	149.7	132.1
1972	341,456	25,618	64,756	36.53	70.5	167.0	153.0	134.5
1973	357,441	26,597	67,251	38.41	71.2	172.8	157.7	138.1
1974	371,649	27,438	69,299	40.13	71.4	177.9	161.4	141.0
1975	371,294	27,169	69,155	40.61	71.6	177.2	159.9	139.2
1976	390,272	28,334	72,152	42.96	71.7	185.2	166.2	144.3
1977	399,355	28,822	73,142	44.16	71.9	188.1	167.8	145.5
1978	409,149	29,346	74,094	45.36	72.1	191.3	169.7	146.8
1979	418,841	29,836	74,580	46.30	72.3	193.7	170.8	147.5
1980	422,444	29,855	74,230	46.95	71.5	194.6	170.7	147.2
1981	419,501	29,445	74,235	47.84	70.7	195.6	170.5	146.9
1982	413,563	28,894	74,355	48.82	69.9	196.4	170.3	146.5
1983	419,399	29,192	76,268	51.02	69.1	202.0	174.2	149.7
1984	432,643	29,995	78,193	53.30	68.4	208.9	179.2	153.8
1985	444,061	30,644	78,944	54.83	67.6	213.1	181.8	155.9
1986	456,239	31,309	79,291	56.11	66.8	216.4	183.7	157.3
1987	461,618	31,478	78,613	56.68	66.1	216.9	183.1	156.6
1988	473,695	32,093	78,936	57.32	66.3	218.7	183.6	156.7
1989	495,870	33,394	80,761	59.07	66.4	224.4	187.4	159.8
1990	516,269	34,531	81,753	60.23	66.6	228.0	189.2	161.1
1991	527,129	34,979	81,814	60.71	66.7	228.4	188.3	160.2
1992	534,486	35,215	81,701	61.06	66.9	228.3	187.0	159.0
1993	536,618	35,105	81,665	61.43	66.9	227.6	185.3	157.4
1994	550,065	35,744	83,079	62.89	66.9	231.3	187.1	158.8

Notes: TFP "without human capital and R&D" only takes into account total hours worked and the non-residential capital stock using factor shares as weights. TFP "with human capital" takes into account total hours worked and 0.6 of the rise in total years of education per person (adjusted for the trend in working hours) which are weighted at the labour share, and the non-residential capital stock weighted at the capital share. TFP "with human capital and R&D" is derived as TFP "with human capital" but with taking into account the change in the R&D stock using a weight of 0.07 on top of the average factor share. The latter weight is based on a calculation of the output elasticity to R&D from Minne (1995).

Sources: Real GDP from 1913-1921, kindly provided by J.P. Smits, are provisional estimates from the research project on Historical National Accounts of the Netherlands (N.W. Posthumus Institute). Real GDP from 1921 onwards from Maddison (1995) which is based on van Bochove and Huitker (1987) for the period 1921 to 1960, and on OECD National Accounts, Main Aggregates for the period 1960-1994. Converted to 1990 guilders on the basis of the EKS purchasing power parity from OECD (1992). For population, employment and hours worked, see Appendix Table A. For physical and human capital stock and stock of R&D, see Appendix Table B.

The share of labour compensation in total GDP at factor cost is derived for 1913, 1921, 1929, 1938, 1947, 1960, 1973. 1979, 1987 and 1993 on the basis of total compensation of employees plus an imputed compensation for self-employed (excluding unpaid family workers), assuming the same compensation per person for self-employed as for employees (van Bochove and Huitker, 1987; CBS, 1994). Intermediate years are derived through logarithmic interpolation.

Notes

* This paper departs from, and makes extensive use of an earlier paper by B. van Ark, J. de Haan and H.J. de Jong, "Characteristics of Economic Growth in the Netherlands during the Post-War Period", *CEPR Discussion Paper Series No. 932*, Centre for Economic Policy Research, April 1994. A slightly revised version of that paper will appear under the same title in N.F.R. Crafts and G. Toniolo, eds., *Economic Growth in Post-1945 Europe*, Centre for Economic Policy Research, Cambridge University Press, 1996. We received useful comments on an earlier draft from participants at the Economic and Social History Seminar at the University of Groningen. We are also grateful for comments from Ronald Albers, Peter Groote, Angus Maddison and Jan Luiten van Zanden. We would like to acknowledge Jan Pieter Smits for providing us with the reestimated GDP growth figures for the period 1913-1921. Gert den Bakker and Jan Jonker (CBS) kindly provided us additional data on employment since 1950. Of course, we remain responsible for the way we used the various estimates in this paper.

1. In a recent paper, Maddison (1996) has provided revised growth accounting estimates for the Netherlands for the period since 1950. The period was then subdivided into two subperiods, i.e. 1950-1973 and 1973-1992.
2. Recently the Central Statistical Bureau has begun revising the national accounts for the 1950s and 1960s to the post-1969 accounts.
3. We take northwest Europe (which consists of Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden, Switzerland and the UK) rather than "OECD Europe" as our reference group. It bears out more clearly the change in the relative performance of the Netherlands to countries in the same per capita income-league.
4. Labour productivity growth was also negative at -1.5 per cent a year on average between 1938 and 1947 (see table 7).
5. See van Ark and de Haan (1996) for a more detailed discussion of the comparative economic performance of the Netherlands since 1960.
6. 1950 from Maddison (1991), tables C.3 and C.4; 1992 from OECD, *Employment Outlook*, July 1995.
7. See Maddison (1991, 1995, 1996) and OECD, *Employment Outlook*, July 1995.
8. See also Maddison (1995a), who questions the unduly high percentage mentioned in the literature and assumed war damage to have been 10 per cent of pre-1946 investment. The estimates of Groote, Albers and de Jong (1996) show that most of the decline in the stock took place in 1944 and 1945.
9. See van Ark, de Haan and de Jong (1994, 1996). Our present estimates show a more rapid rise in capital intensity during the 1950s compared to the 1960s, because of an upward adjustment in the growth rate of the capital stock during the 1950s and an upward adjustment in the growth of employment during the 1960s. See appendices B and C.
10. See, for example, Lucas (1988) and Mankiw, Romer and Weil (1992). See Kendrick (1976) for an empirical approach in estimating the tangible and intangible stock of capital.
11. Intermediate years were obtained by interpolation. See Albers, Clemens and Groote (1994) for a calculation of stock of human capital on the basis of an accumulation of past enrollment in primary education. Their 1913 estimate shows a level of 3.9 years of primary education per head of the population,

which suggests 6.4 years per head in the age category of 15-64 year. This is more than Maddison's estimate of 5.3 years of primary education.

12. See Minne (1995). Minne suggests there has been very little investment in R&D before 1932 (see pp. 131-136), but other evidence suggests a substantial rise in the number of scientists working in laboratories of industrial firms during the first half of the century.
13. See Barro and Sala-i-Martin (1995, chapter 1) for a discussion of the traditional Solow-Swan model. See also Rensman (1996) for a discussion of growth models in relations to the measurement of economic growth.
14. See, for example, Romer (1994) and Lichtenberg (1992).
15. See, for example, van Ark (1994).
16. Estimates of unemployment rates are difficult to compare in an international perspective because countries use different methods, and frequently change their procedures. In order to maintain comparability between countries and over time we followed Maddison in using "the percentage of the labour force which was not in employment", which is also comparable to the estimates in the OECD *Labour Force Statistics* and OECD *Employment Outlook*. However, recent CBS estimates for the period 1929-1938 show higher average unemployment rates for the Netherlands, namely 14.2 per cent (Den Bakker and Van Sorge, 1991).
17. Deflating nominal wages by a producer price index instead of a consumer price index results in an annual decline of real wages by 2.2 per cent in the same period. In 1950 the share of labour costs in manufacturing industries was only 19 per cent of total output value, which was the lowest level of the period under review (calculated from the CBS Production Statistics).
18. See van Ark (1994), who compares relative levels of unit labour cost in manufacturing, showing that these were even lower than in the United States in 1994.
19. See de Jong and Oude Vrielink (1993).
20. See Mason, Prais and van Ark (1992) for a study of the relationship between vocational training and productivity on the basis of plant comparisons between the Netherlands and the United Kingdom. See also Prais (1995). On the basis of a cross-section comparison, O'Mahony also showed the significant contribution of differences in average skill levels of the work force on the comparative productivity levels by industry between Germany and the United Kingdom.
21. For an international comparison, see, for example, Minne (1992) and MERIT (1994, 1995).

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